Status of the Secondary Target

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PANDA-Meeting December 10th, 2013

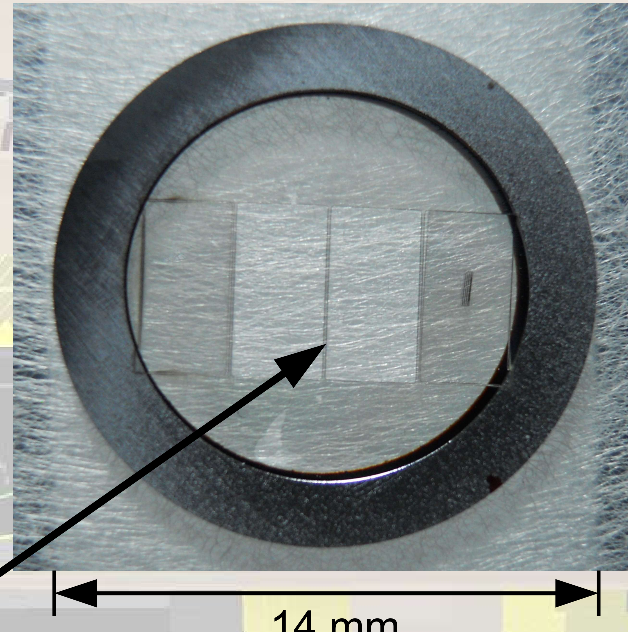
Primary target

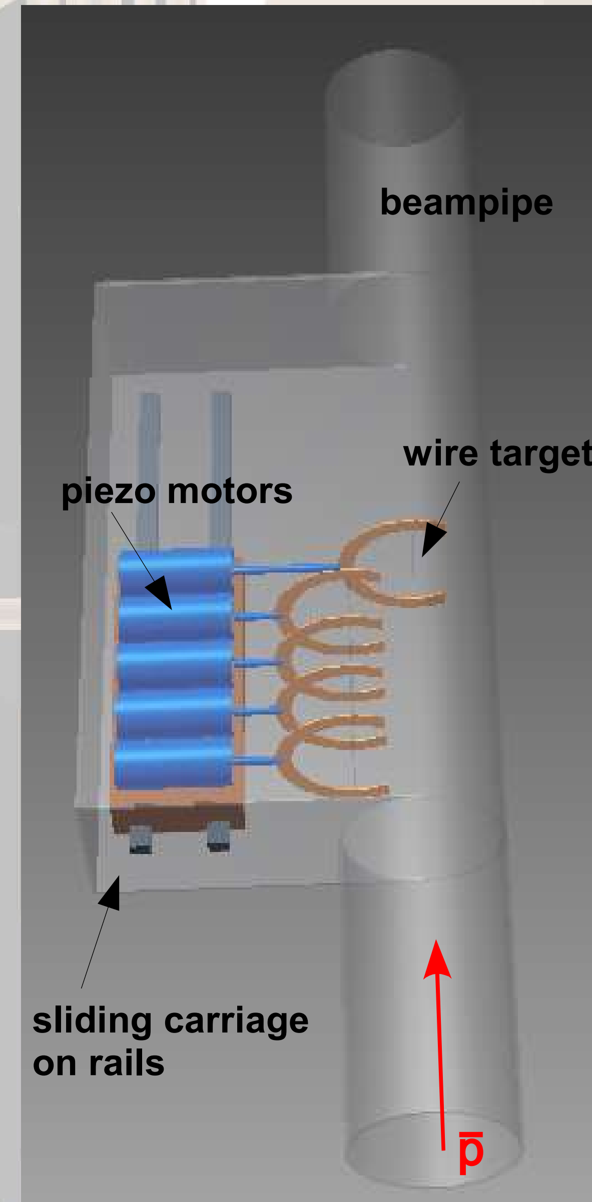
Task of the primary target:
production of slow Ξ^-

Requirements:

- minimal hadronic background in backward direction
- constant luminosity of $\bar{p}$-beam
  $\Rightarrow$ beam losses, mainly due to coulomb scattering, must be kept low

$\Rightarrow$ ^{12}C micro-wire target with thickness 3 µm, width 100 µm





Insertion to the beam:

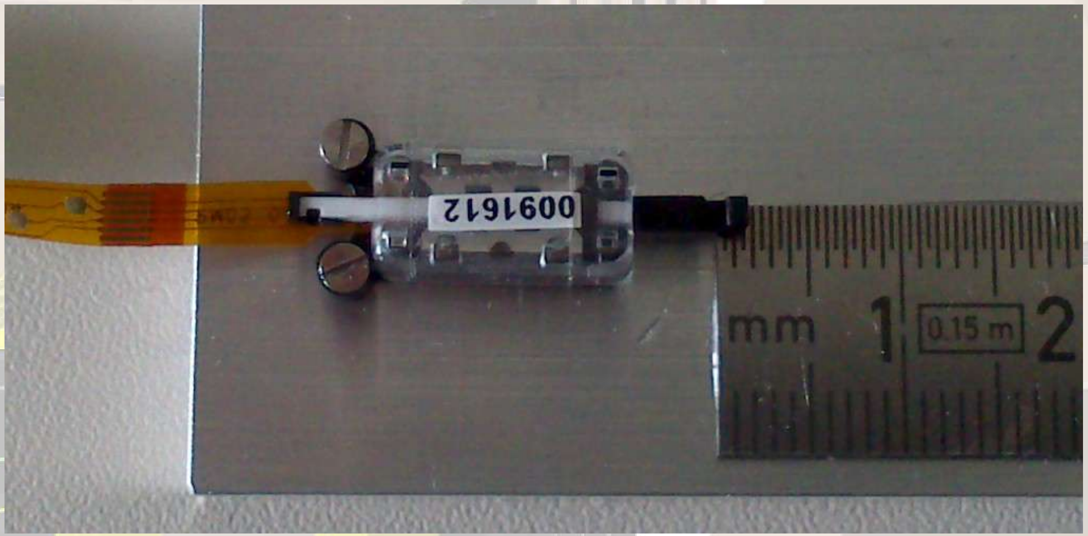
- controlling interaction rates by moving target into beam halo
- easy replacement

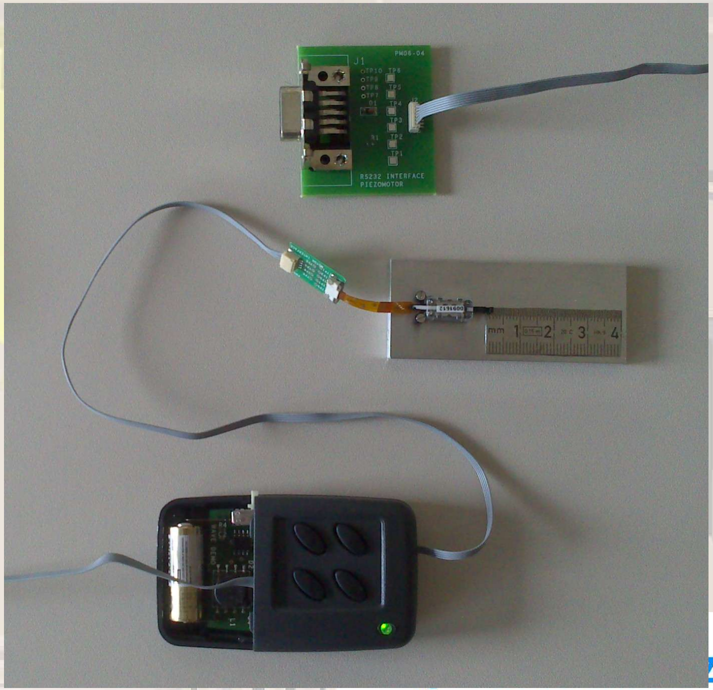
Piezo motor

First piezo motor for tests:

PiezoWave Linear 0.1 N
Manufacturer: PiezoMotor Uppsala AB

<u>Specifications:</u>
Stroke max: 8 mm
Maximum speed: 50 - 100 mm/s
Average step: 0.5 - 1.0 µm
Dynamic force: 0.1 N
Holding force: 0.3 N
Weight: 0.5 g
Size: 14.0 mm x 7.2 mm x 4.4 mm





Running the motor:

The PiezoWave is operated by the Starterkit Demo-Wave-10.

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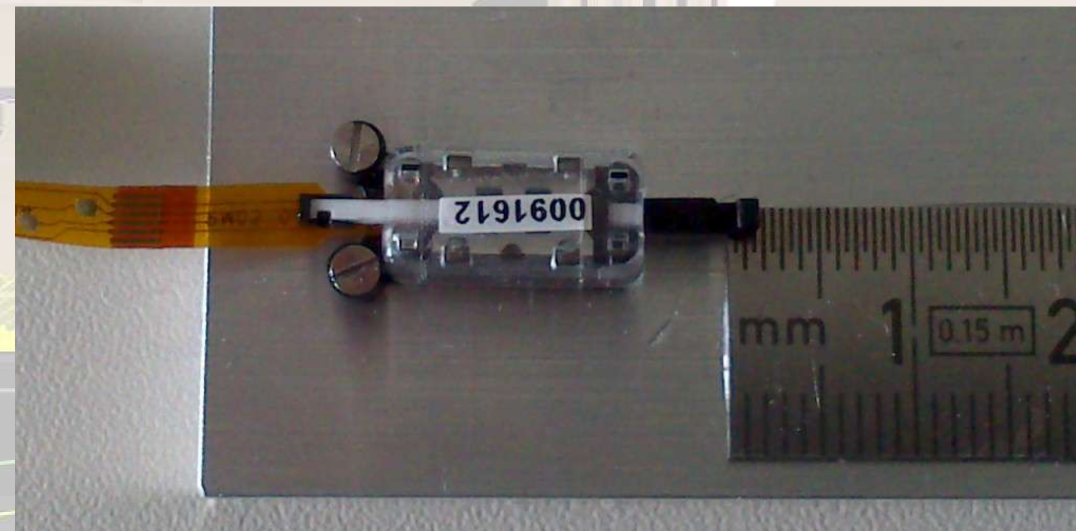

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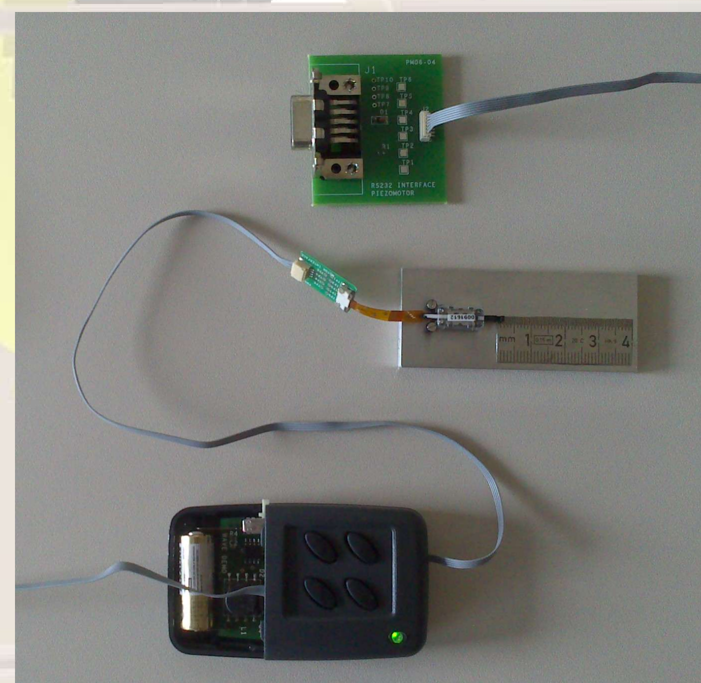

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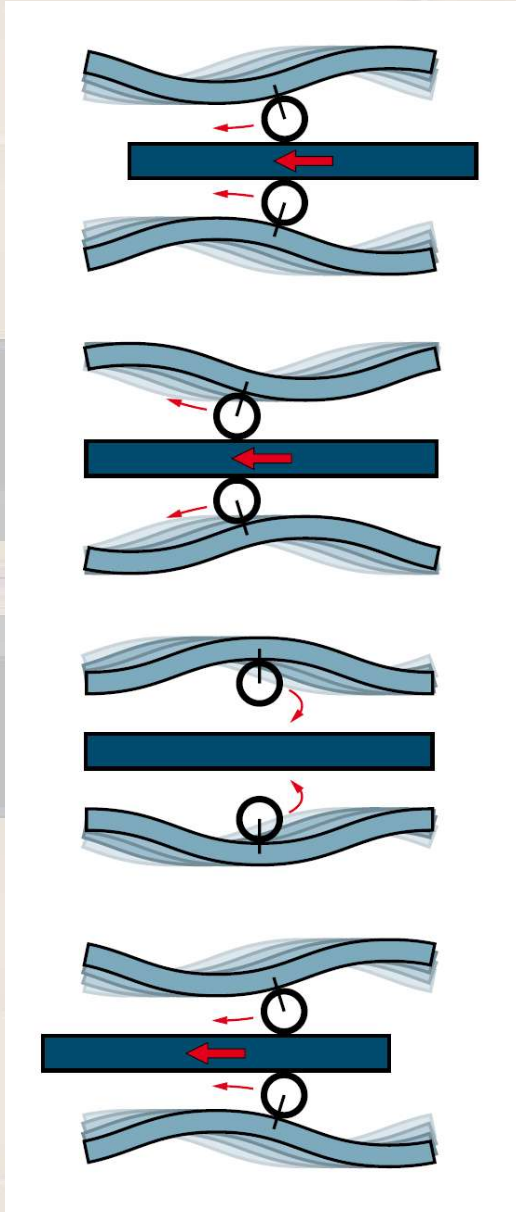
Piezo motor - principle

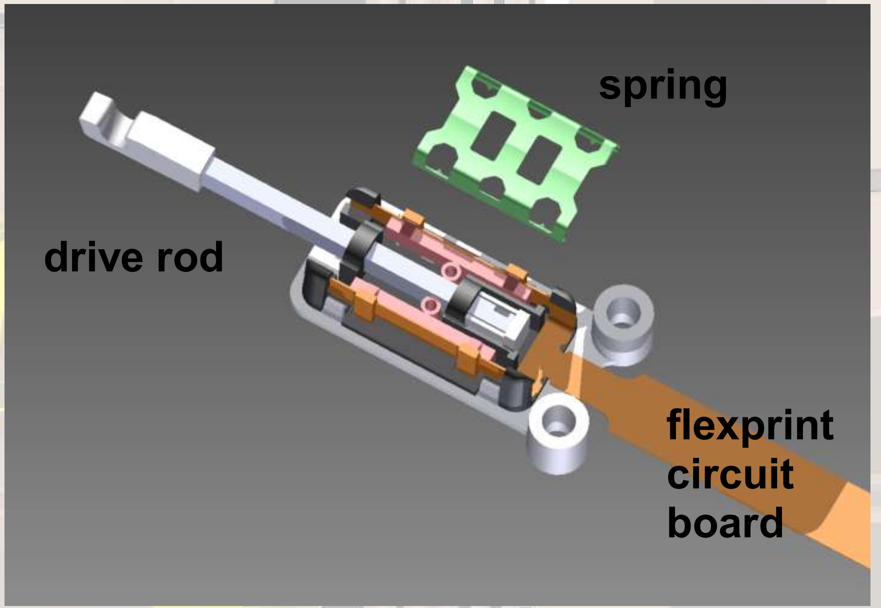


Two piezo ceramic elements with drive pads move when activated
⇒ drive rod moves

End of first motion cycle

Repositioning

Next step

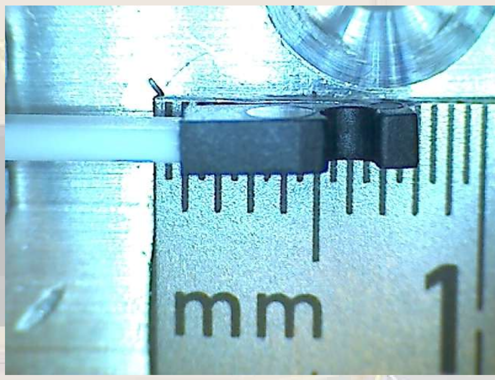


Motion is transferred by contact friction

→ no power consumption in holding position
→ determines the holding force
→ drive rod slides at large impact force

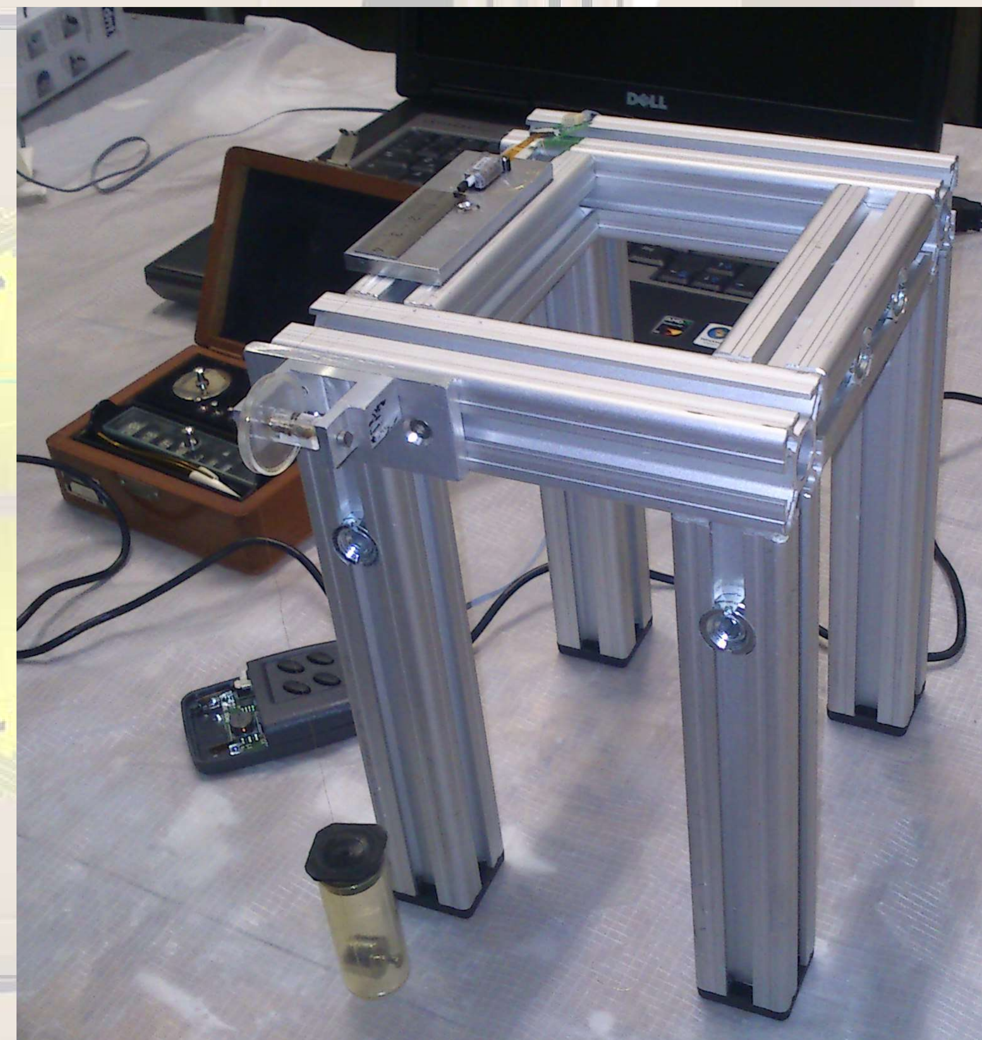
Experimental tests

- Measurement of the average step size with the help of a microscope:



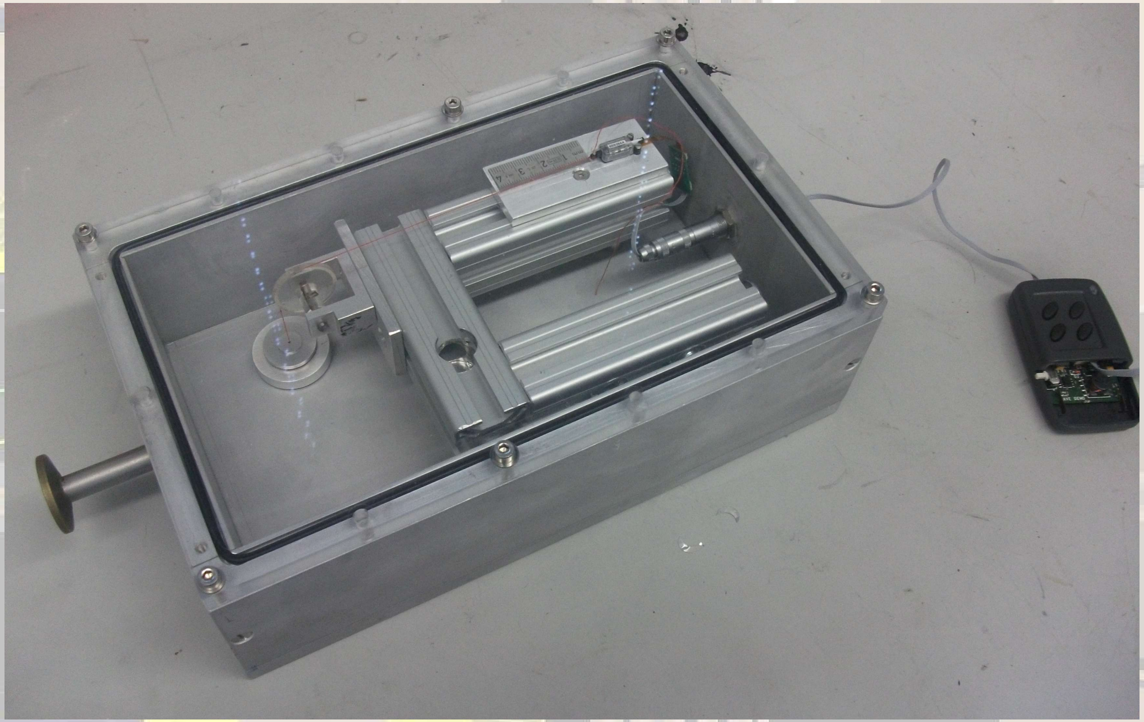
0.96 µm → precise enough but differs

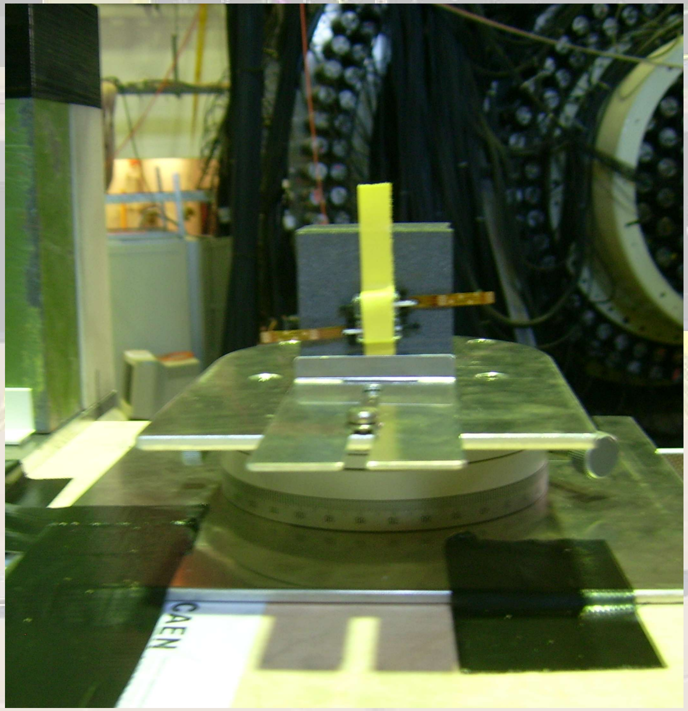
- Measurement of the forces with weights:
  dynamic force = 0.14 N → sufficient
  holding force = 0.88 N
- Test in vacuum:
  proper running proved for some weeks
- Test in a magnetic field of 1.3 T:
  no influence discovered



Experimental tests

- Combined measurement of the forces in vacuum with weights:
  dynamic force = 0.15 N
  holding force = 0.90 N
- Beam test at COSY in Jülich:
  no radiation damage discovered





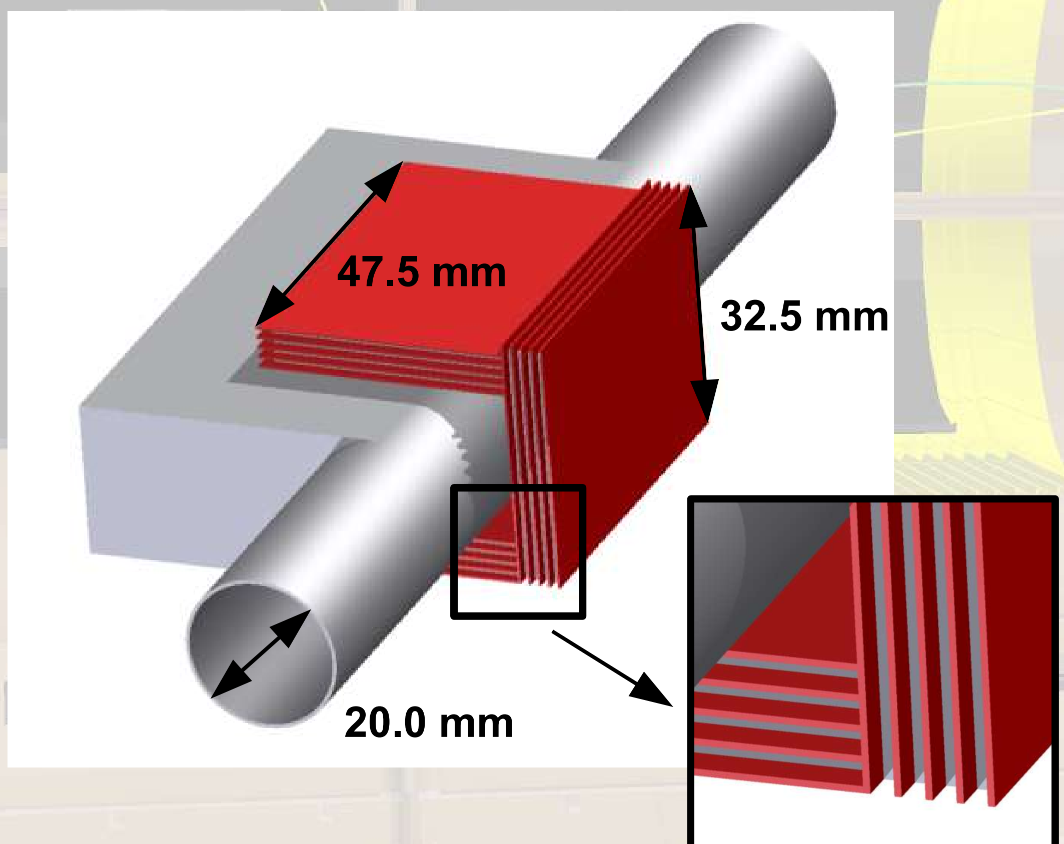
Conclusion:

- Specifications of PiezoWave confirmed or better than declared
- Demands for the hypernuclear experiment fulfilled

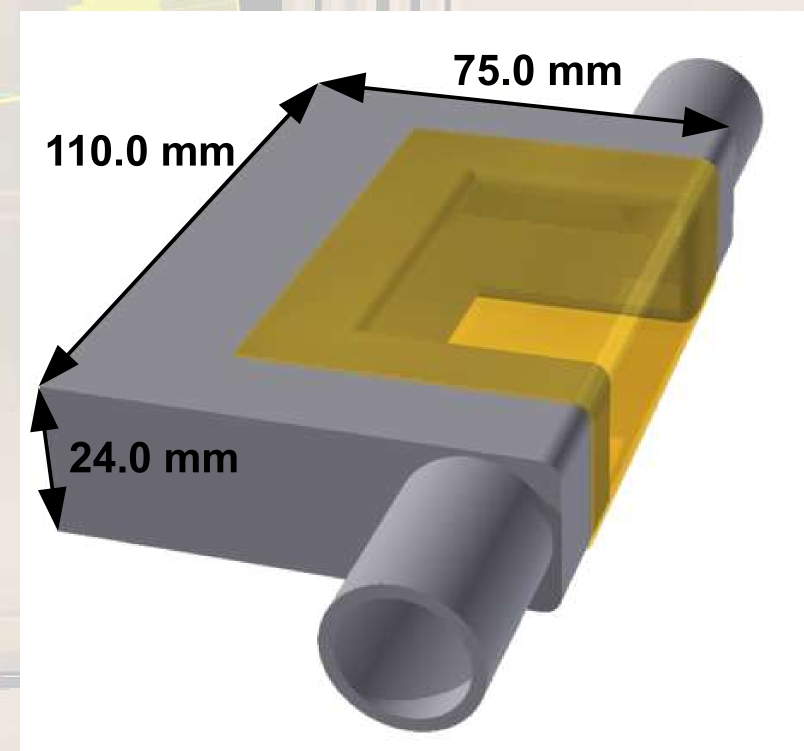
Design of the target system

Very short life time of Ξ^-: $\tau = 0.164$ ns ⇒ compact structure essential

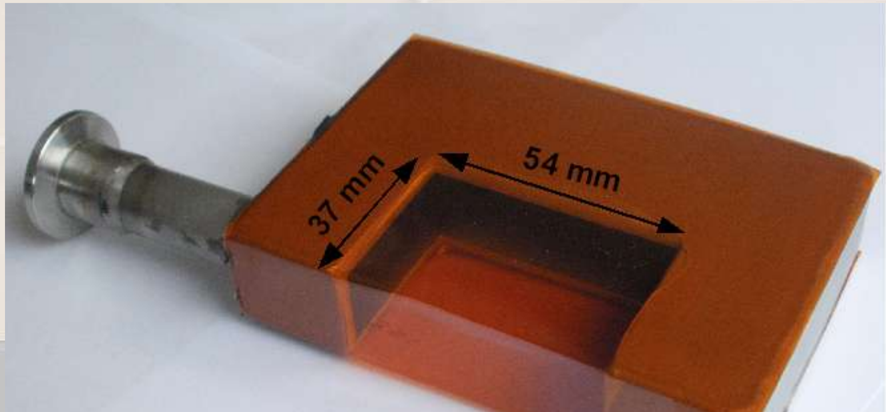
Arrangement of DSSD-absorber-assemblies directly around the target chamber and beampipe
→ minimization of beampipe diameter



Minimization of material budget
→ reduction of thickness

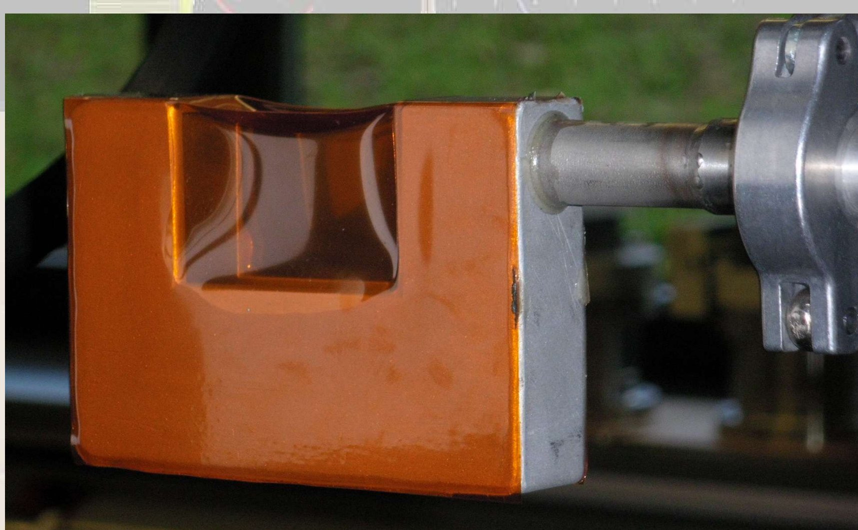


Target chamber studies



Foil, 1st try:
Kapton, thickness 75 μm

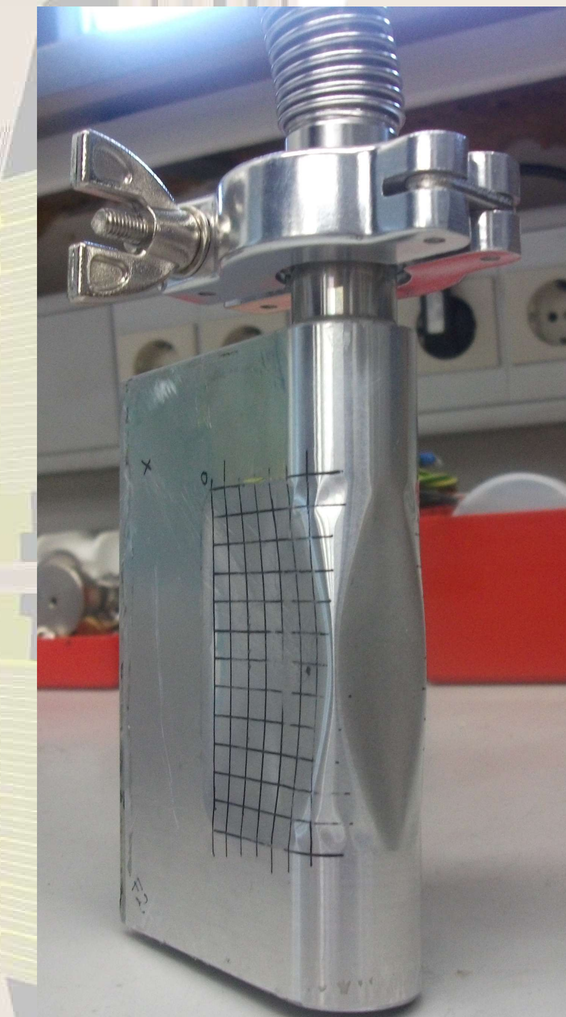
Stability tests in vacuum:



Target chamber studies

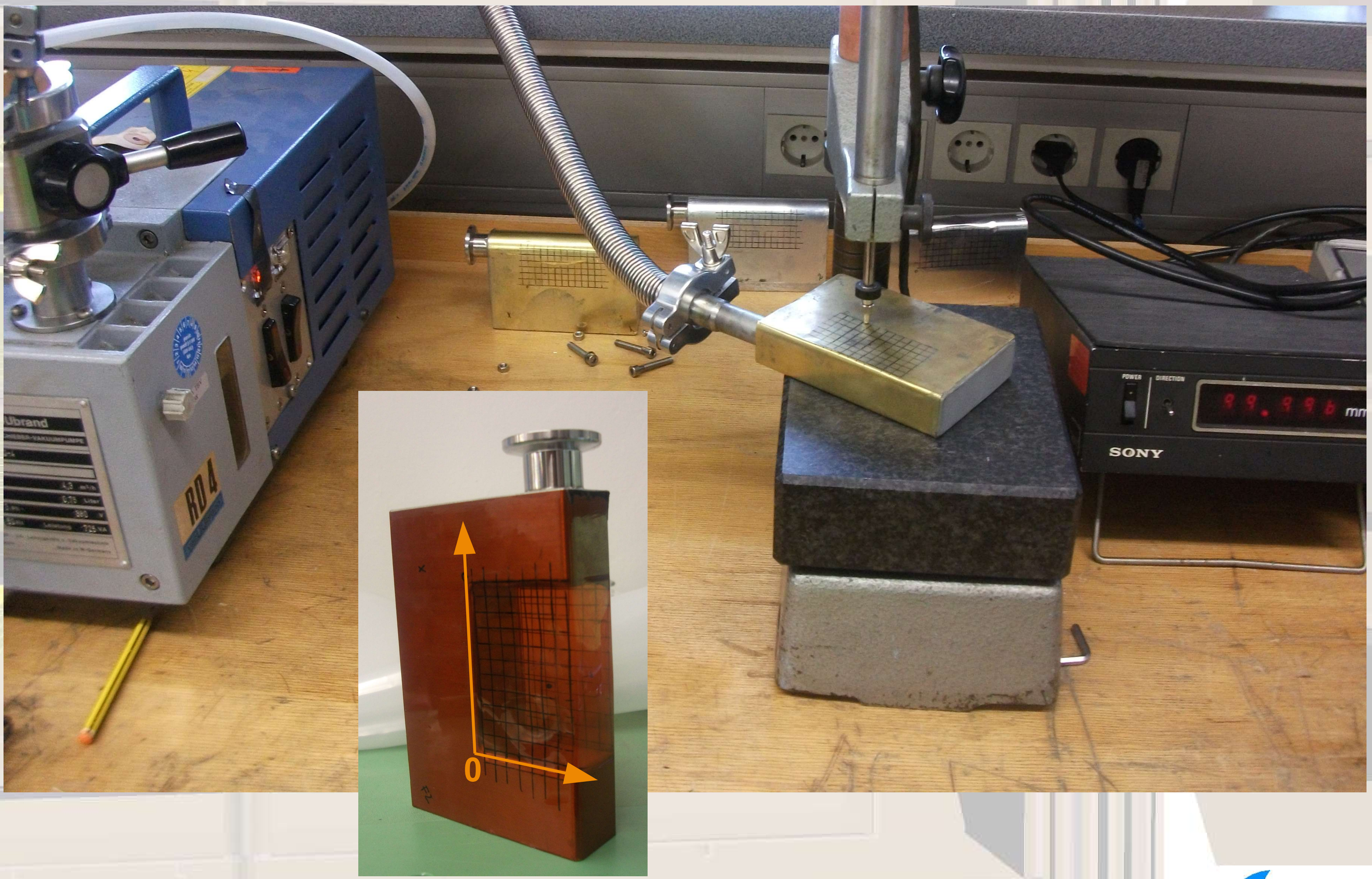
Brass, 200 µm

Titanium, 200 µm



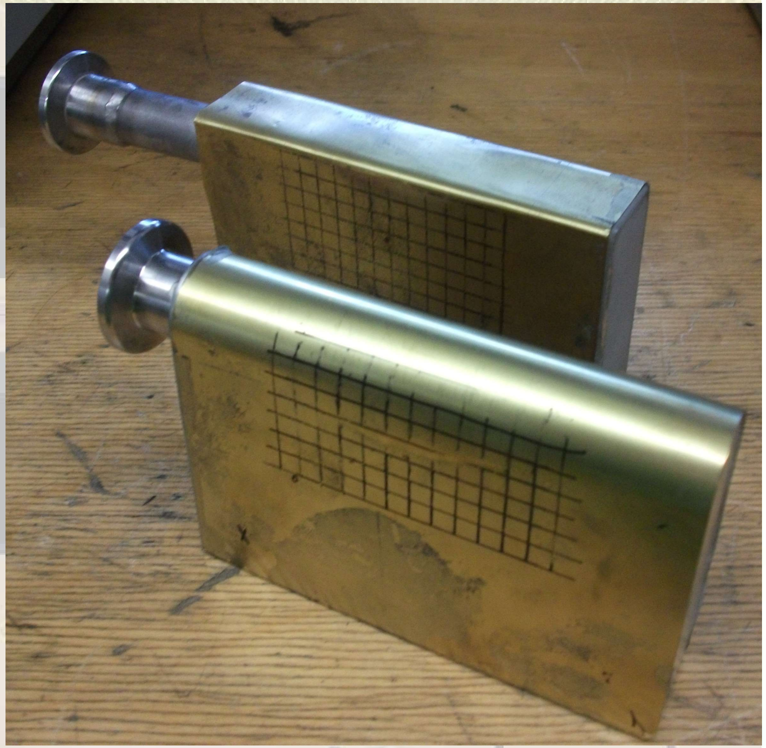
Alloy AlMg3, 100 µm

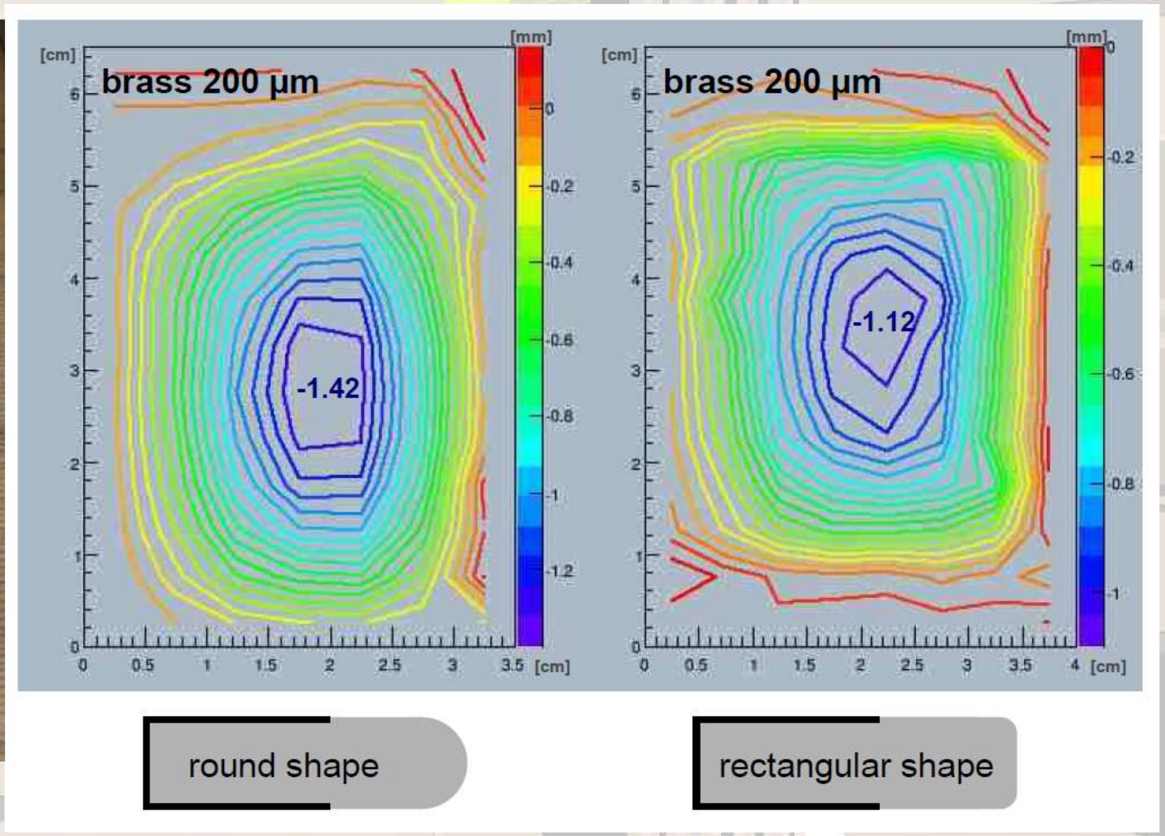
Setup for measurements



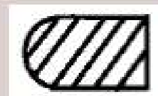
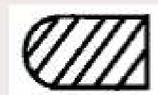
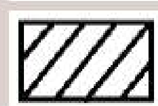
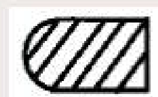
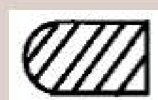
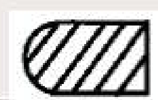
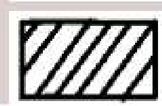
Target chamber measurements

Two shapes in comparison → bending smaller for rectangular shape





Target chamber measurements

Material	Density (g/cm³)	Chamber Model	Thickness(μm)	Maximum depth(mm)
Titanium	4.54		200	1.22
Titanium	4.54		140	2.09
Brass	8.5		200	1.12
Brass	8.5		200	1.42
AlMg	2.66		200	1.86
AlMg	2.66		100	2.195
Kapton	1.42		140	4.72

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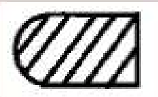
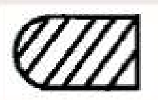
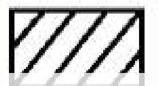
Titanium	4.54		200	1.22
Titanium	4.54		140	2.09
Brass	8.5		200	1.12
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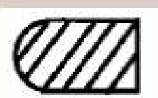
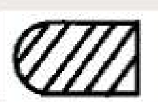
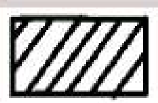
AlMg	2.66		200	1.86
AlMg	2.66		100	2.195
Kapton	1.42		140	4.72

Not convenient for vacuum applications

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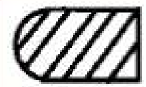
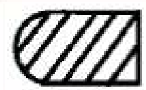
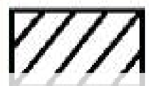
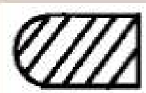
Titanium	4.54		200	1.22
Titanium	4.54		140	2.09
Brass	8.5		200	1.12
Brass	8.5		200	1.42
AlMg	2.66		200	1.86
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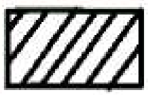
Kapton	1.42		140	4.72

Not convenient for vacuum applications

Persistent deformation

Target chamber measurements

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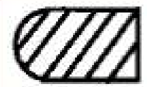
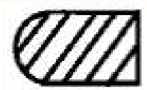
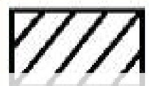
Titanium	4.54		200	1.22
Titanium	4.54		140	2.09
Brass	8.5		200	1.12
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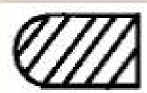
AlMg	2.66		200	1.86
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Not convenient for vacuum applications

Persistent deformation

Bending too strong

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Design of the secondary target

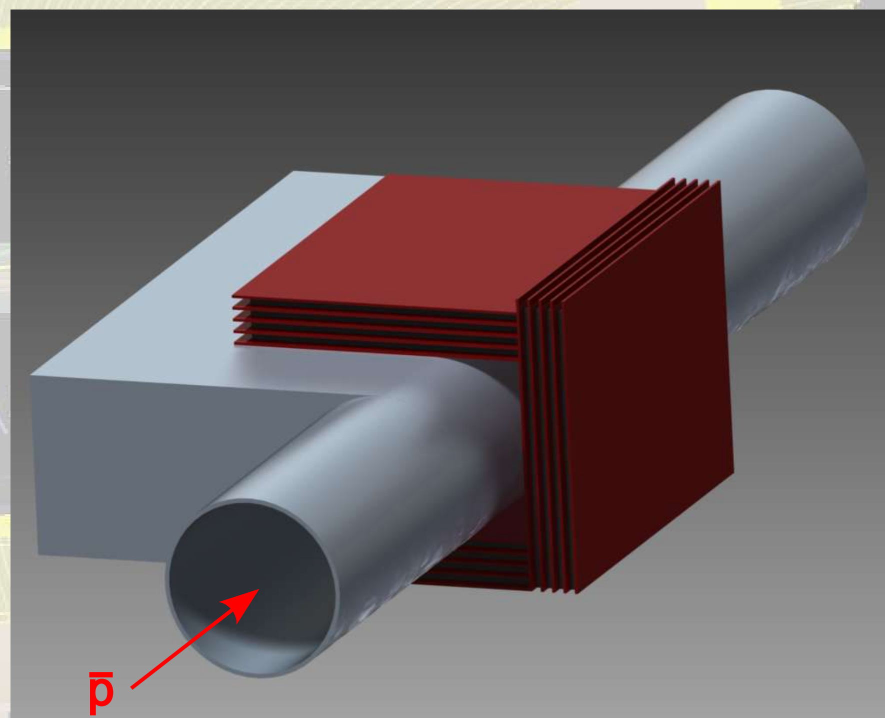
Requirements for the secondary target

- adjusted to stop time and life time of Ξ^- (τ = 0.164 ns) as well as geometry

  ⇒ compact structure without gaps (t_{stop} ≈ 0.06 ns)

- tracking of Ξ^- and the decay products of Λ-Λ-hypernuclei

  ⇒ alternating layers of Si strip detectors and absorber material



red:

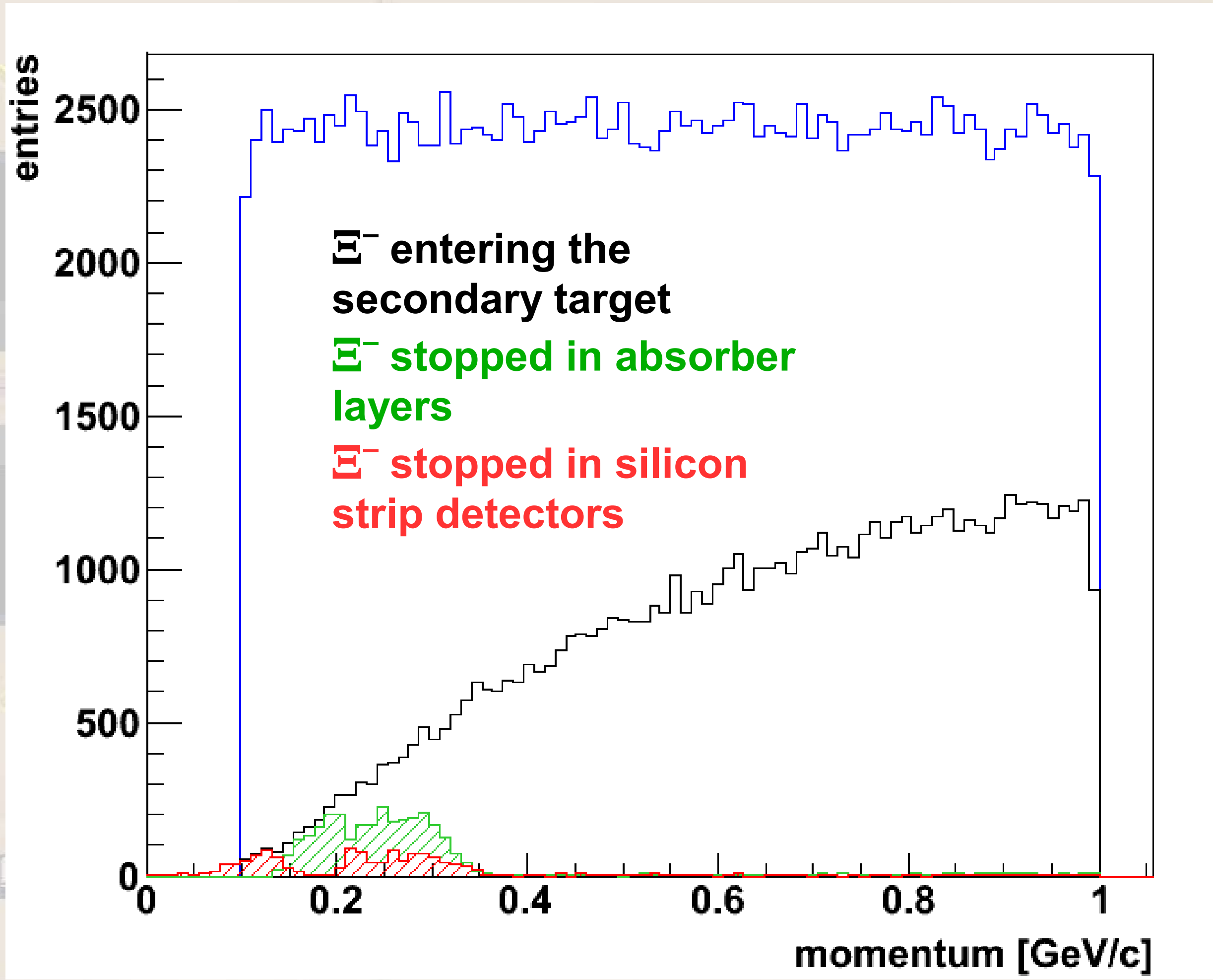
5 layers of double sided silicon strip detectors (thickness 300 μm) in each block

gray:

4 layers of absorbers (thickness 1 mm) different for each block (^{9}Be, ^{10,11}B or ^{12,13}C)

Stopping of Ξ⁻

Simulation of 200,000 Ξ⁻ in the uniform momentum range from 0.1 to 1.0 GeV/c by the box generator

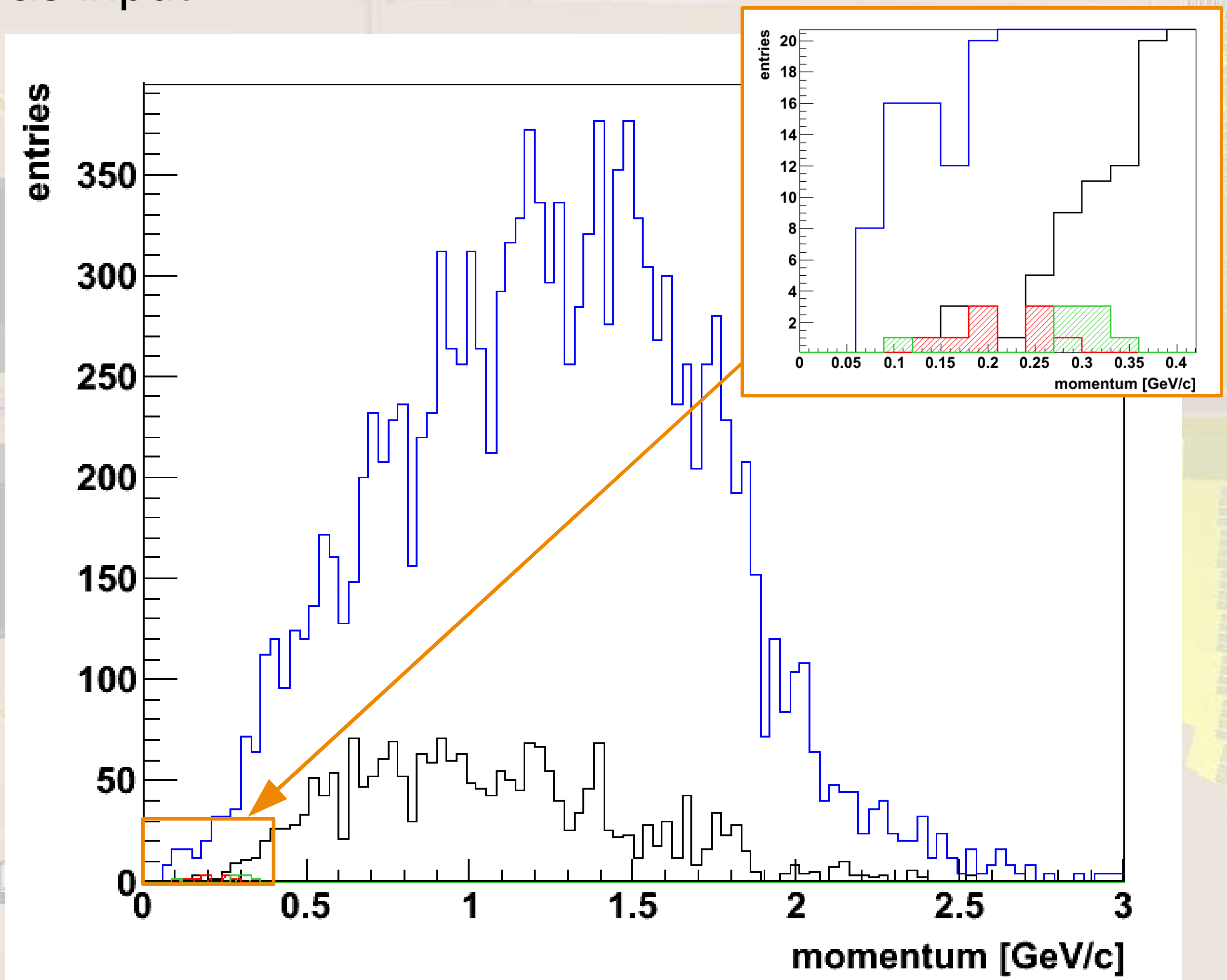


Momentum distribution at the vertex and of stopped Ξ⁻ at the entrance of the secondary target

→ Only Ξ⁻ in the momentum range from 0.1 to 0.4 GeV/c can be stopped

Stopping of Ξ^-

Ξ^- out of GiBUU simulations with $\bar{p}$ on ${}^{12}_{6}C$ at 3 GeV/c as input



Momentum distribution of Ξ^- from GiBUU simulations and their results after stopping in the secondary target

→ 0.07% of the generated Ξ^- are stopped in beryllium

Detection of Ξ^-

Plan so far:

detection of Ξ^- by energyloss in silicon strip detectors

Idea now:

look inside the Ξ^- events of GiBUU calculations to see
if these have a certain signature that can be used for the identification

Possible advantages:

- No need to start with a sensor layer but with an absorber
- Broadening of this absorber to stop more Ξ^-
- Separation of the stopping of Ξ^- and the tracking of pions optimized only for this task
  $\Rightarrow$ Easier mechanical integration

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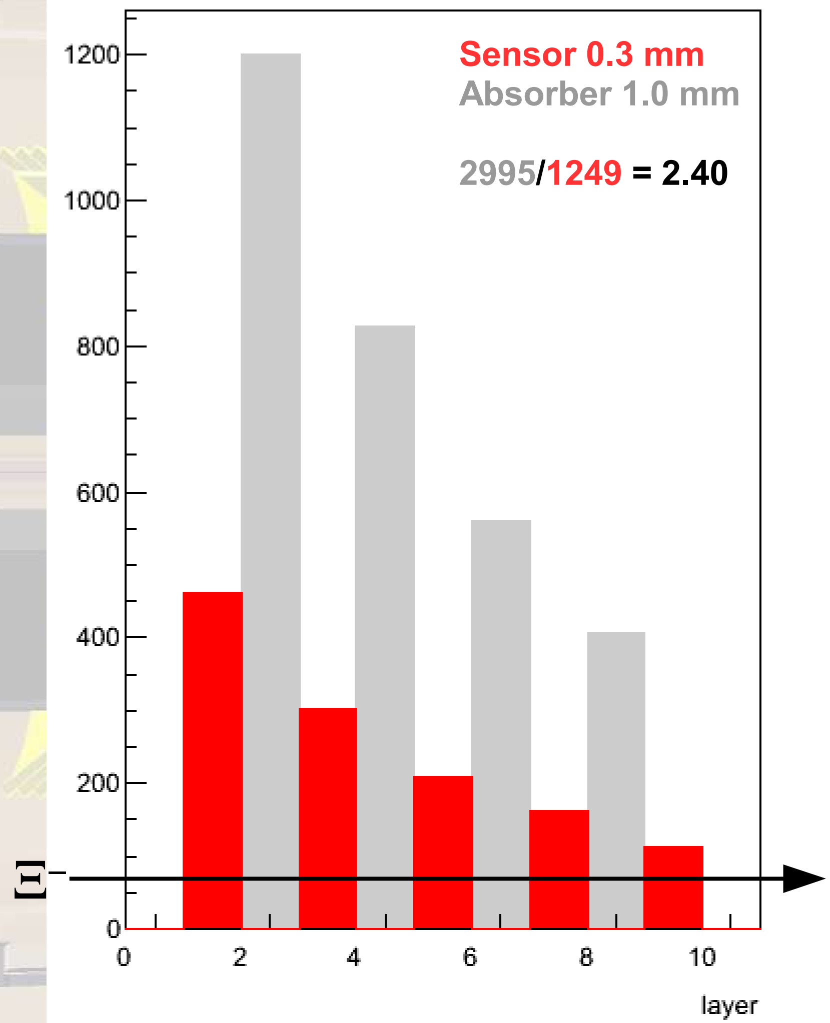
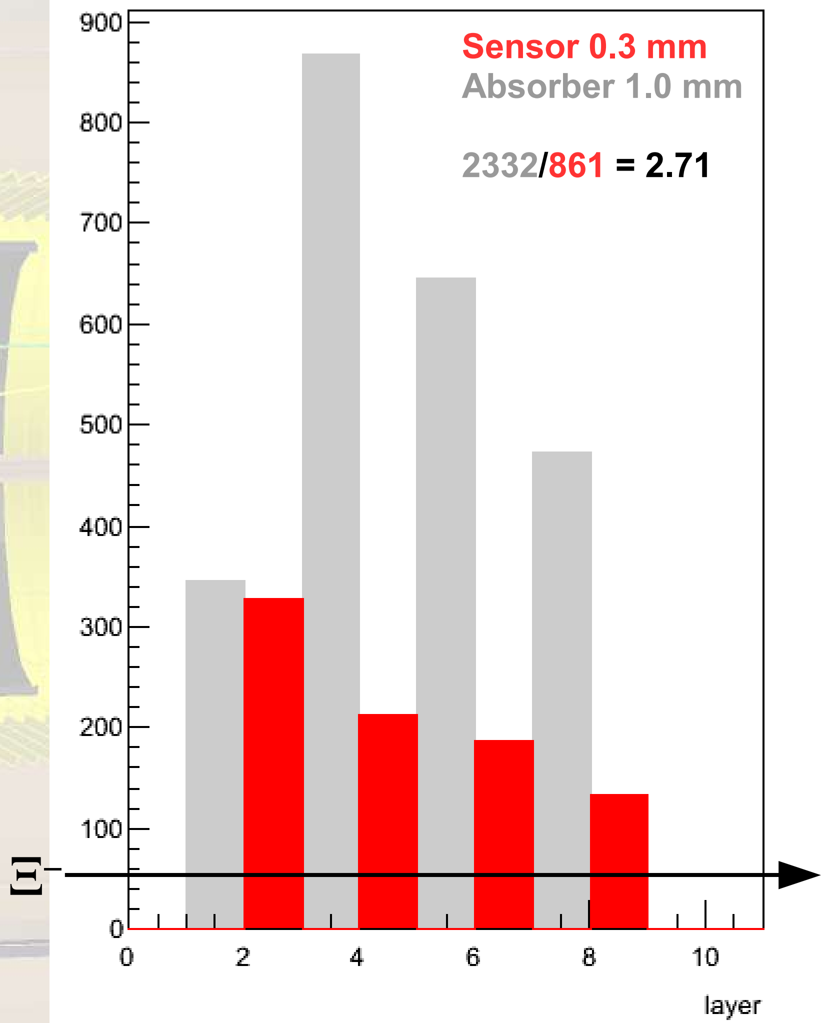
Stopping of Ξ^-





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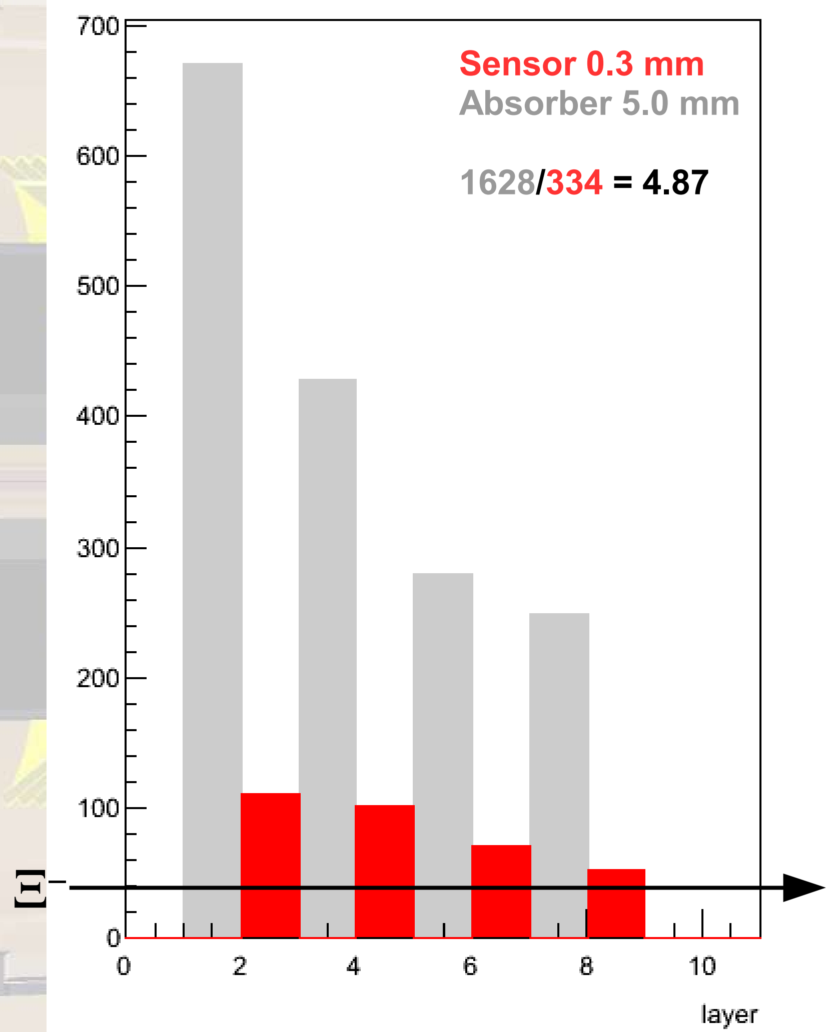

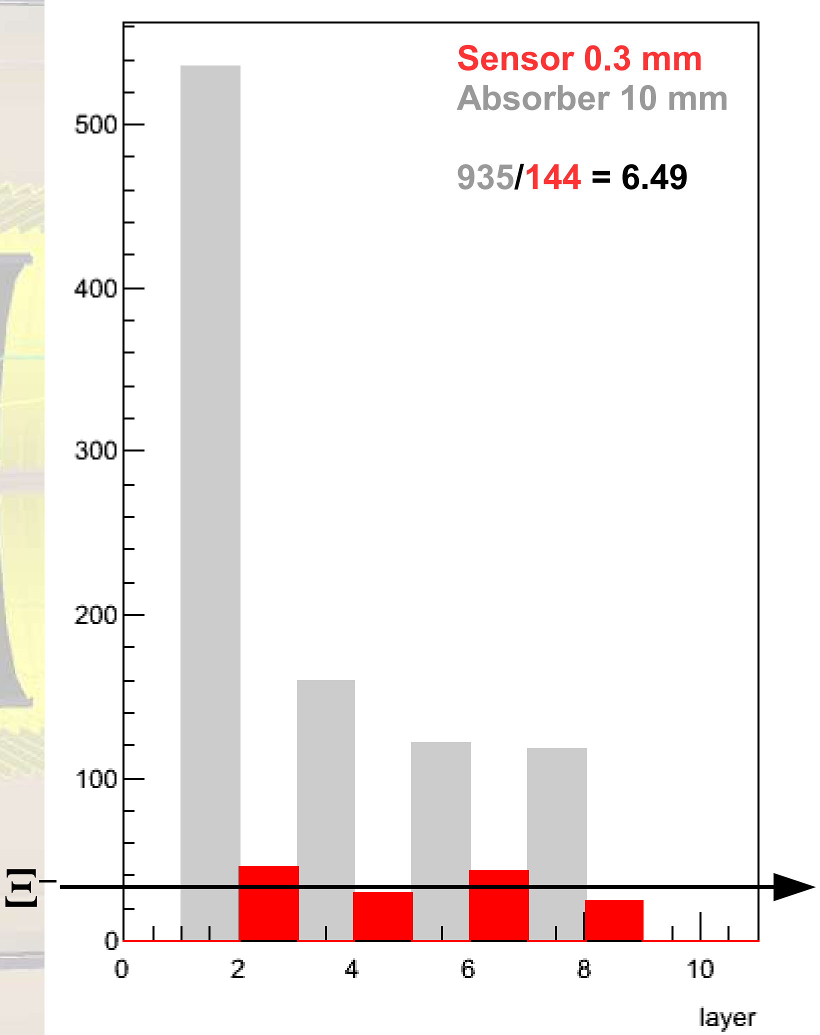

Outlook

- ongoing GiBUU simulations
- look at events with Ξ^-
- study the arrangement and thickness of the layers in case of the stopping of Ξ^- and the pion tracking (use the stopping points of Ξ^- as starting point for pions)